SDF Flow Sensor

Operating and Installation Manual

BA-SDF-en-L-1503

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1. General

1.1. Symbols

Hazard warning (Caution, observe documentation)
ISO 3864, no. B.3.1

1.2. General Note

For the sake of clarity this manual does not contain detailed information about all types of products and cannot take every conceivable case of installation, operation or maintenance into consideration. Please contact us directly for further information or in case of problems, which are not sufficiently explained in this manual.
May we draw your attention to the fact that the contents of the manual are not part of a previous or existing agreement, approval or legal relationship or an amendment thereof. All obligations of S.K.I. GmbH result from the purchase contract, which also contains the entire and solely valid warranty agreement. These contractual warranty conditions are neither extended nor restricted by the contents of the manual.

W A R N I N G

This equipment should only be installed and operated after *qualified personnel* has made sure that during normal operation or in case of malfunction no potential dangers emanate pro the equipment or parts thereof. Danger of serious injuries and/or considerable damages in case of improper handling. The manufacturer is not responsible for these injuries/ damages.

Safe and faultless operation of this equipment requires proper transport, correct storage, assembly and installation a well as attentive operation and maintenance.

Unless stated otherwise, SDF Sensors are designed for static loads according to AD2000 and EN13480 respectively. They are not designed for external static loads.

1.3. Qualified Personnel

are persons familiar with the installation, assembly, commissioning and operation of the product and who have the appropriate qualifications for their activities such as:

- Training, instruction or authorization to operate and maintain devices/systems according to the standards of safety technology for pressure components.
- Training or instruction in maintaining and operating appropriate protective equipment according to safety standards.
- First Aid training.

**** Caution:** Before installation and operation the pipework and process data must be checked against the specifications on type label and delivery note. Only the specifications on the type label of the equipment apply.*

Deployment In Explosive Environs

Applicable national standards and regulations are to be complied with if the equipment is deployed in potentially explosive atmospheres.

2. Incoming Goods Inspection

Any shipment leaving S.K.I. GmbH is inspected to the best of our knowledge and with great care.
Nevertheless, it is necessary for the customer to crosscheck as soon as possible after receipt of the delivery. Only then legitimate claims can be settled quickly and without further dispute.

Check upon receipt of goods:

- **consistency of type label (see below)/ type code (see page 5) and delivery note;**
- **consistency of delivered and ordered version, especially correct sensor length, sensor material and component materials, as far as possible;**
- **consistency of the scope of delivery with the order confirmation;**
- **documentation (operating manual, flow calculation (see below), drawings, etc.).**

Figure 1: Type Label SDF

Pressure Differential Calculation For SDF Sensors

Date	8 November 2010			
Customer	S.K.I. GmbH			
Project	41320001			
Tag no./measuring point				
Process	internal			
Pipe and sensor data				
Pipe cross section	round			
SDF sensor type no.	SDF22			
Inner diameter (cold)	250mm			
Wall thickness	4mm			
Insulation	0mm			
Pipe material	carbon steel (St37 or similar)			
k factor (cold)	0.6522			
Design and calculation criteria				
Type of medium	air			
Calculation	according to current volume flow			
State and process variables				**Unit**
Temperature	15	45	15	°C
Absolute pressure	100.3	100.3	100.3	kPa abs.
Cinematic viscosity	1.5e-05	1.8e-05	1.5e-05	m2/s
Operating volume flow	2700	1800	1800	m3/h
Operating density	1,225	1,1	1,225	kg/m3
k factor (warm)	0.6522	0.6522	0.6522	
Inner diameter (warm)	250.0	250.1	250.0	mm
Expansion number	0.9996	0.9999	0.9998	
Flow velocity	15.28	10.18	10.19	m/s
Reynolds number	256393	144213	170929	
Results				
Calculated pressure differential	3.36	1,34	1,49	mbar
Remaining pressure loss	0.39	0.16	0.17	mbar

set point for pressure differential

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Figure 2: Pressure Differential Calculation

3. Type Code Excerpt

SDF	**Pipework installation**
M	Weld-in union with mechanical joint
F	Mounting flange
DF	Steam sensor with mounting flange
X	Special version
	Profile type
10	"10"
22	"22"
32	"32"
50	"50"
	Inner diameter (Numerical value with unit)
	Wall thickness (Numerical value with unit)
	Sensor material
S	W. no. 1.4571 (316 Ti)
15	W. no. 1.5415
H	W. no. 2.4819 (Hastelloy C276)
HT	W. no. 2.4816 (Inconel 602)
X	Special material
	Installation component materials
C	Carbon steel
E	W. no. 1.4571
15	W. no. 1.5415
X	Special version
	End support
0	none
SC	End support with pipe thread and cap
GG	Closed end support
GF	End support with flange
X	Special version
	Pressure stage (e.g. "PN16", "300 lbs" or similar)
	Process connections
N2	Nipple with 1/2-14-NPT male thread
N4	Nipple with 1/4-18-NPT male thread
R2	Nipple with R1/2" male thread
R4	Nipple with R1/4" male thread
R	Pipe element 12mm
S	Hose stem ∅8x1mm
FP	Flange plate for mounting 3-way valve block
KT	Steam version with condensate container up to 400°C in compact design made of 1.4571
X	Special version
	Primary shut-off
0	none
KE	Ball valves made of 1.4401
ACx	Shut-off valves made of carbon steel
AEx	Shut-off valves made of 1.4571 (different versions)
DEx	3-way valve block made of 1.4401 (with flange plate only, different versions)
FEx	5-way valve block made of 1.4401 (different versions)
	Special accessories
0	none
VC	1 pair of screw joints for pipe connection 12mm, carbon steel
VE	1 pair of screw joints for pipe connection 12mm made of 1.4571
DSE	3-way valve block with 1/2"-NPT female thread for direct installation on electric pressure differential transducer, made of 1.4571
FWNC	Weld-on 5-way valve block for direct installation on electric pressure differential transducer
T	Integrated temperature sampling with PT100m class B, 3-pole
UE	Multi-way cock PN100 with flush connections made of 1.4401
	Pipe run
H	Horizontal
V	Vertical (also inclined run)

Table 1: SDF Type Code Excerpt
Find a complete type code in our technical information for SDF sensors.

4. Installation Instructions

4.1. General Note

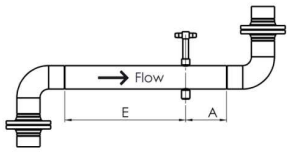
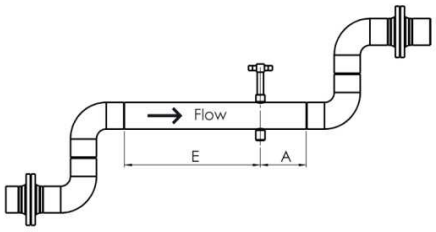
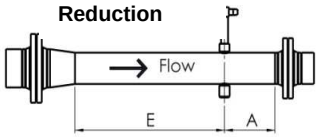
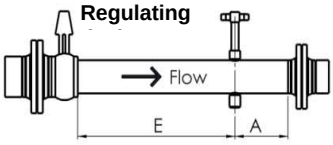
During installation observe applicable national regulations, especially:

-Pressure Equipment Directive 97/23/EG (if applicable);
-related standards, such as AD2000 or DIN EN 13480 (if applicable);
-Machine Directive 2006/42/EG (if applicable);
-depressurise pipework and/or channel before installation/disassembly;
-clean pipework if toxic/harmful media are present before installation/disassembly.

4.2. Determine installation location

Find the longest straight part of pipework or channel and divide this into upstream and downstream distance respectively according to the table below.

Required calming sections

Pipe run	Upstream	Downstream
	**7*ID**	**3*ID**
	**10*ID**	**3*ID**
	**7*d**	**3*ID**
	**20*ID**	**5*ID**

The indicated upstream and downstream distances are reference values. They can be shortened by "intelligent" installation. What does „intelligent installation" mean?

Example 1: **Sensor installation downstream of elbow**
The flow profile mainly deforms in the plane of the elbow. Therefore the sensor should be installed in the same plane in order to detect the variations in velocity at the individual measuring points.

Example 2: **Correct installation is not possible at the measuring point due to structural conditions**
This can be remedied by correction of the SDF sensor's k factor. This is done by means of a testing instrument (e.g. a pitostatic tube) to determine the flow velocity at the sensor's installation location and comparison with the displayed value at the stationary measuring equipment. In case of deviations the application-specific k factor must be calculated from the calculation formulae and the measuring equipment must be re-parameterised. Find details in a special application report, if required.

For more information contact our consulting and commissioning service.

Table 2: Required Upstream And Downstream Sections

Pay attention to interferences existing upstream and downstream of the selected installation location. Passive elements (e.g. elbows) cause less interference than active elements (e.g. fans). Harmonic changes in the pipe run (elbows with large radii, reductions according to DIN) are more favourable than sudden or less harmonic changes (corners, stops). Contact the manufacturer or responsible sales engineer, if necessary!

4.3. Determine installation position

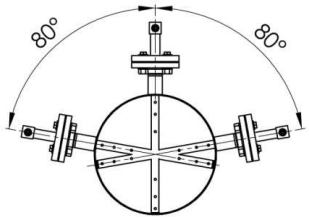
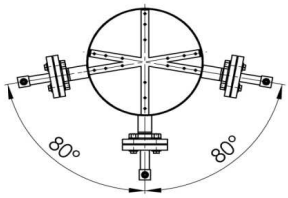
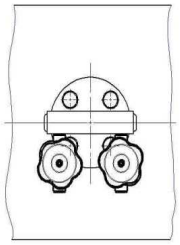
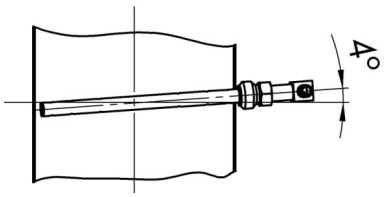
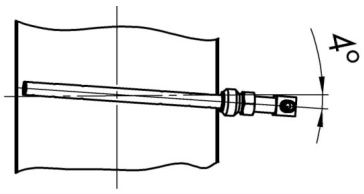
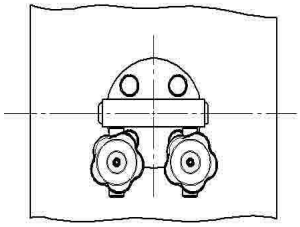
Gases	Liquids	Steam
for horizontal pipe run		
		
Sensor installation upward between -80° and +80° position	Sensor installation downward between -80° and +80° position	Sensor installation always level
for vertical pipe run		
		
Slightly inclined installation between 0° and 4° of sensor to enable the condensate to flow away from the sensor head back into the process.	Slightly declined installation between 0° and 4° of sensor to enable air or gas bubbles to return into the process (incline opposite to gases).	Sensor installation always level
Height offset calculation of end support for vertical pipe run		
Deviation between: 0° 1° 2° 3° 4°	 0mm 0,017 x $\varnothing_{outer}$ 0,035 x $\varnothing_{outer}$ 0,052 x $\varnothing_{outer}$ 0,070 x $\varnothing_{outer}$	On same height as installation component!

Table 3: Determine installation position (illustrations apply for SDF M sensors (mechanical joint) as well as SDF F sensors (flange), SDF S sensors (weld-in sensors), SDF DF sensors (steam sensors) and FASTLOK sensors.

4.4. Orientation SDF Flow Sensor

SDF flow sensors are completely symmetric. For this reason it is irrelevant which of the perforated sensor sides faces the flow. Consequently the arrow indicating the flow direction only shows whether the SDF flow sensor is designed for horizontal or vertical flow. In addition the connections are marked with the letters **LK** (left sensor chamber) and **RK** (right sensor chamber) for horizontal pipes and with **OK** (upper chamber) and **UK** (lower chamber) for vertical pipes. The design of the sensors ensures that the connections are always on the same level, meaning that the flow-indicating arrow on sensors for vertical pipelines is offset by 90° with regard to the connections. The sensors must be installed with the engraved letters normally readable (in upright position).
The following table shows the allocation of sensor chamber and transmitter connection depending on pipe run and flow direction. The pipework is to be carried out accordingly.

Pipe run	Flow direction	+ side of transducer	- side of transducer
horizontal	from left to right ➔	LK	RK
horizontal	from right to left ➔	RK	LK
vertical	from top to bottom ➔	OK	UK
vertical	from bottom to top ➔	UK	OK

Table 4: Chamber Allocation/Inflow Side For Flow Direction

Alignment tolerances for SDF sensors considering points 4.2. and 4.3.:

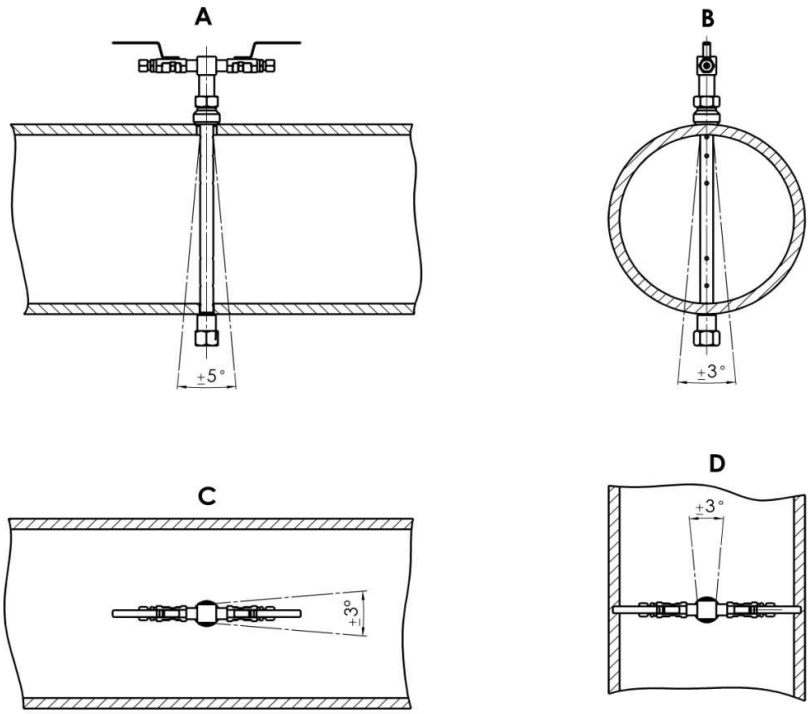


Figure 3: Alignment Tolerances For SDF Sensors (A: axial orientation, B: radial orientation, C: orientation to flow direction in horizontal pipe run, D: orientation to flow direction in vertical pipe run). Observe for steam sensors points C and D in chapter 4.6.1.

4.5. Mounting Installation Components (Main Bearing)

4.5.1. SDF-M (Cutting Ring Installation Component)

The pipe wall must be drilled to D_M (see Table 5) at the installation location .Before inserting the weld-in connection screw on the screw-down nut but remove the cutting ring to avoid tension due to heat. Now insert the mounting piece, tack-weld it and align perpendicular to pipe axis. After finishing the weld around the mounting piece, insert the cutting ring and securethe union nut with several turns.

Necessary torque (T_A) according to
ISO 9974-1/ ISO Union nut 52-T1-Form X/ DIN 3852-T3-Form W (metric thread) **of installation component for SDF-M:**

- SDF-**M**-10: $T_A \approx$ Cutting ring
- SDF-**M**-22: $T_A \approx$ 330 Nm
- SDF-**M**-32: $T_A \approx$ Mounting Piece

(Above values only for reference and must be observed for every application!)

Figure 4: Olive Installation Component

4.5.2. SDF-F (Flange Installation Component)

The pipe wall must be drilled or welded to D_F (see Table 5) at the installation location. Then place the flange on the pipe and tack-weld. Align the flange perpendicular to pipe axis. Attach the flange to enable functional sensor installation. The alignment of the flange drill holes must correspond with Figure 6. Now finish the weld of the installation flange.

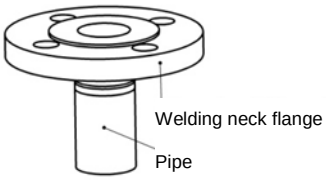


Figure 5: Flange Installation Component

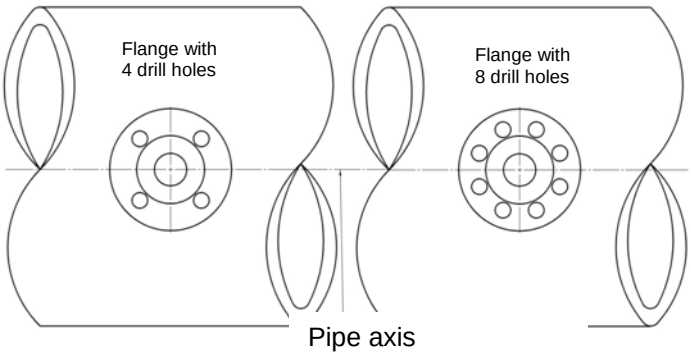
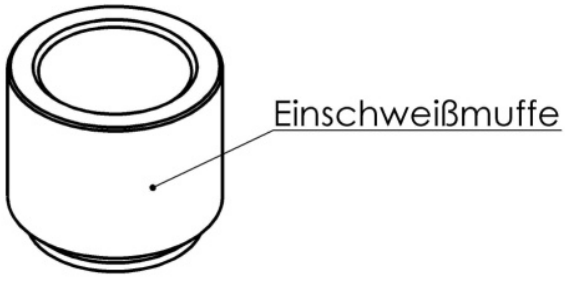


Figure 6: Alignment Of Flange Installation Component



4.5.3. SDF-S (Weld-In Installation Component)

The pipe wall must be drilled or welded to D_S (see Table 5) at the installation location. Now insert the welding sleeve, tack-weld and align perpendicular to pipe axis. After finishing Welding Sleeve sleeve insert the sensor, align and tack-weld. Now finish the weld.

Figure 7: Weld-In Installation Component (Welding Sleeve)

Sensor Type	Weld-In Connection (M)	Flange Installation Component (F)	Welding Sleeve (S)
SDF-M-...-10	D_M = 21mm[1]	-	
SDF-F-...-10	-	D_F = 17mm[2]	
SDF-S-...-10			D_S = 16mm[3]
SDF-M-...-22	D_M = 37mm[1]	-	
SDF-F-...-22	-	D_F = 38mm[2]	
SDF-S-...-22			D_S = 29mm[3]
SDF-M-...-32	D_M = 53mm[1]	-	
SDF-F-...-32	-	D_F = 44mm[2]	
SDF-S-...-32			D_S = 39mm[3]
SDF-F-...-50	-	D_F = 83mm[2]	
SDF-S-...-50	-		D_S = 61mm[3]

Table 5: Bore Diameters

For pressure stages from PN63 the bore diameter D_F of the flange installation component corresponds with the inner diameter of the used welding neck flange. For welding sleeves the bore diameter D_S is 2mm greater (special designs may include deviating bore diameters)!

4.5.4. End Support Installation

Follow the installation steps below if the sensor is fitted with an **end support**:
First stipulate the installation location of the end supports; it is positioned exactly opposite the mounting component.

Recommended procedure for stipulating the opposite point:
First mark the centre of the installation component to be installed on the pipe. Then pass a tape of at least 30mm width and appropriate length tightly around the pipe and align it in such way that after one turn it exactly covers the first layer. Start by holding one end of the tape to the point marked on the pipe. Mark the tape at the point, which after one turn is directly adjacent to the marked centre of the installation component. The distance from the start of the tape to this point is equal to the outer diameter of the pipe. Remove the tape and determine the centre between the start of the tape and the point marked on the tape, and mark the centre of the tape. Place the tape again around the pipe as described above. The point marked last on the tape (centre) is the position exactly opposite the installation component. Finally you only have to transfer this point to the pipe. If there is no tape available you can also use a cord to determine the diameter. In this case it is important to check the axial alignment of the cord by measuring the distance to the next flange.

Now install the installation component as described above.
Then drill or weld a respective hole at the opposite point (see above). Find the required diameter in the following Table:

[1] Bore diameters apply for the installation of sensors with cutting ring installation. Please contact us for drill hole sizes for directly welded sensors above (SDF-S: regularly used for high pressure)!
[2] Bore diameters apply for sensors with flange installation up to and including PN40. Above pressure stage PN 40 the bore diameters correspond with the inner diameters of the used flange according to DIN EN 1092.
[3] Bore diameters apply for sensors up to and including PN40. Above pressure stage PN 40 or for special designs the bore diameters may deviate and must be enquired separately.

Sensor Type	Closed End Support (GG)	End Support With Cap (SC)	End support With Flange (GF)
SDF-...-10	17mm[4]	-	-
SDF-...-22	30mm[1]	30mm[5]	38mm[6]
SDF-...-32	38mm[1]	38mm[2]	44mm[3]
SDF-...-50	60mm[1]	-	83mm[3]

Table 6: Bore Diameter For End Support (for pressure stages from PN63 the bore diameters D_F of the flange installation components correspond with the inner diameter of the used welding neck flange!)

The end support is tack-welded to the pipe and aligned in such way, that the end support aligns with the previously welded installation component. This guarantees trouble-free insertion of the sensor without wedging.

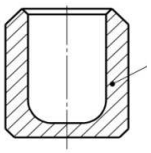
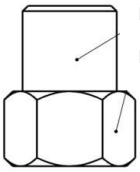
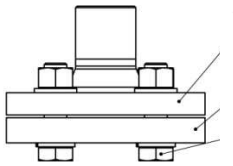
Overview Different End Support Versions		
Closed End Support (GG)	Pipe Thread With Cap (SC/SE)	Flanged End Support (GF)
		

Table 7: Overview End support

Note: Ensure that the drill hole in the pipe (SDF10=14mm, SDF22=26mm, SDF32=34mm and SDF50=54mm) is completely kept as passage und weld the end support to the pipe.

Recommended procedure for end support alignment:
After drilling insert the sensor or a straight pipe with respective outer diameter through the installation component already installed and loosely slide the end support over the projecting sensor end or pipe. Tack-weld it to the pipe after properly aligning the end support (do not wedge!). Remove the sensor or pipe, and complete the weld.

After installing the sensor cover the end support with the supplied cap or blind flange, depending on the version.

[4] For special designs the bore diameters may deviate and must be enquired separately.
[5] This design can only be utilized up to a certain pressure stage (max. PN40 and depending on the temperature resistance of the sealant).
[6] Bore diameters apply for sensors with flange installation up to and including PN40. Above pressure stage PN 40 the bore diameters correspond with the inner diameters of the used flange according to DIN EN 1092.

4.6. Installation Of “Standard” Sensors For Liquids And Gases

SDF-M After all installation components and the end support (if required) are attached the sensor can be inserted in the union nut, which is only screwed on the welding flange with a few turns. The flow direction arrow on the sensor head must be aligned with the flow direction. Two cases are to be differentiated. For installation without end support ensure that the sensor touches the opposite pipe wall. When installing with end support the sensor is inserted until the distance between the external pipe wall and the lower edge of the sensor head amounts to approx. 80mm (for SDF-10) and 100mm (for SDF-22 and ASDF-32) plus possibly present neck extension H. The sensor point reaches approx. 30mm into the end support. Finally the union nut is firmly tightened.

SDF-F After all installation components and the end support (if required) are attached the sensor can be inserted after inserting a seal between installation flange and sensor flange. The flow direction arrow on the sensor head must be aligned with the flow direction. Finally both flanges are bolted together.

SDF-S After all installation components and the end support (if required) are attached the sensor can be inserted in the welding sleeve. The flow direction arrow on the sensor head must be aligned with the flow direction. Two cases are to be differentiated. For installation without end support ensure that the sensor touches the opposite pipe wall. The distance between the external pipe wall and the lower edge of the sensor head amounts to approx. 80mm (for SDF-10), 100mm (for SDF-22 and SDF-32) or 120mm (for SDF-50) plus possibly present neck extension H. When installing with end support the sensor is inserted until the distance between the external pipe wall and the lower edge of the sensor head amounts to 80mm (for SDF-10), 100mm (for SDF-22 and SDF-32) or 120mm (for SDF-50) plus possibly present neck extension H. The sensor point reaches approx. 30mm into the end support. Finally the sensor is welded to the welding sleeve.

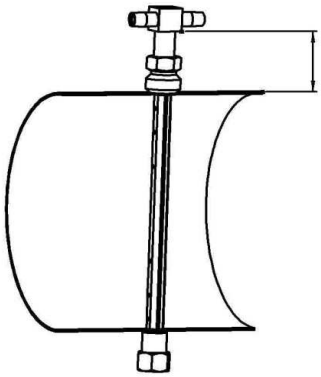


Figure 8: Neck Extension For SDF-M Sensors

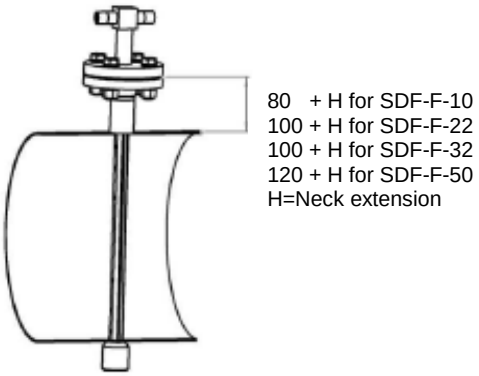


Figure 9: Neck Extension For SDF-F Sensors

4.6.1 Steam Sensor Installation

Generally installation is similar as above. Observe the following particular characteristics.

- Ensure during installation that the condensate pots are installed on exactly the same level.
- Place a spirit level on condensate pots or compact head for alignment.

See further information and details in chapter 6.

4.6.2. FASTLOK Sensor Installation

The complete FASTLOK sensor assembly including transporting pipe and safety guard and/or drive spindle is pre-assembled. For initial installation in the pipework first the installation support including shut-off ball valve must be disassembled from the shut-off pipe (see further information about FASTLOK sensors in chapter 4.8).
During the **initial installation** of a FASTLOK sensor the pipe must be **depressurised** and **emptied** before installing the welding support! The sensor can be removed later under process conditions**.**

The pipe wall must be drilled or welded at the installation location:

SDF-L/S/N/HD-10: ∅ 18mm **SDF-L/S/N/HD-22: ∅ 31mm**

SDF-L/S/N/HD-32: ∅ 38mm **SDF-L/S/N/HD-50: ∅ 57mm**

The weld-in support for the ball valve must be tack-welded in such way that the drill hole in the pipe is entirely kept as passage. Now align the installation component with the inner bore perpendicular to the pipe axis and weld it to the pipe.

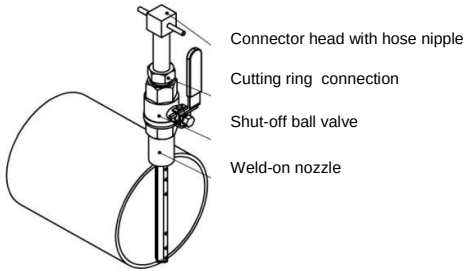


Figure 10: FASTLOK-L Sensor Design

IMPORTANT NOTICE

For FASTLOK sensors with gate valve support the sensor due to the high weight in a suitable manner.

Due to the specific installation process of FASTLOK sensors installation and disassembly need more space than a standard SDF sensor. Take this fact into consideration when stipulating the installation location. Space requirements in sensor removing direction:

FASTLOK-L: OD + insulation thickness + 350mm
FASTLOK-S: 3 x OD + 4 x insulation thickness + 850mm
FASTLOK-N: 3 x OD + 4 x insulation thickness + 1000mm
(OD = pipe outer diameter)

If this space is not available at FASTLOK-S and FASTLOK-N sensors the shut-off pipe can be unscrewed above the ball valve with the ball valve closed. This reduces the necessary space requirements to:

FASTLOK-S: 2 x OD + 3 x insulation thickness + 800mm
FASTLOK-N: 2 x OD + 3 x insulation thickness + 900mm
(OD = pipe outer diameter)

Further FASTLOK Sensor Installations:

FASTLOK L	FASTLOK S	FASTLOK N

The supplied ball valve is screwed on the weld-in support and in here the mechanical joint is screwed and sealed.	The supplied ball valve is screwed on the weld-in support and in here the transporting pipe with packing gland is screwed and sealed.	The supplied ball valve is screwed on the weld-in support and in here the transporting pipe with packing gland is screwed and sealed. Observe the following **component alignment** with each other under all circumstances: The transporting pipe has at the end with the packing gland a female thread connection for the drive spindle. This spindle connection must be exactly perpendicular to the pipe axis after sealing the screw joint. This ensures that the inserted sensor is properly aligned with its drill holes and will face the flow direction correctly.
After sealing the ball valve can be closed and the pipe pressurised with process pressure!		

Table 8: Final Installation Procedure for FASTLOK Sensor

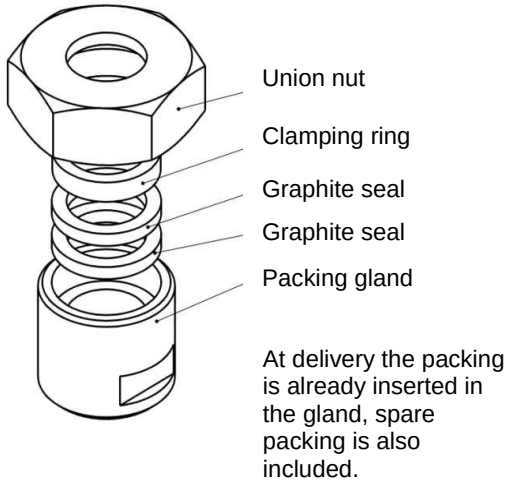

Union nut
Clamping ring
Graphite seal
Graphite seal
Packing gland
At delivery the packing is already inserted in the gland, spare packing is also included.

Figure 11: Packing Gland Design

4.7. FASTLOK Sensor Installation And Positioning

FASTLOK sensors can be installed under process conditions.

FASTLOK L Installation

FASTLOK L sensors are only suitable for media, whose discharge is not harmful, since during installation and disassembly media is discharged for a short time. Installation and disassembly should be performed by two persons to minimize media discharge.

1. Insert the SDF sensor with the tip in the mechanical joint and align with the flow arrow in correct orientation.
2. Open the shut-off ball valve and slide the SDF sensor into the pipe until it touches the opposite pipe wall.
3. Fix the sensor in this position and tighten the mechanical joint. Ensure that the alignment is not changed.

FASTLOK S and FASTLOK N Installation

Ball valve must stay **closed** up to point 4 if the pipe is already pressurised.

1. Carefully insert the sensor with the point, without wedging, in the gland with the union nut loosened, if necessary.
2. For type N: While inserting the sensor further in the transporting pipe the lower end of the drive spindle (remove lock nut at the lower spindle end!) must reach into the spindle connector. Turn the hand crank to move the sensor all the way to the ball valve, without putting pressure on it. Place the lock nut in this position on the lower end of the spindle and fix with the grub screw.
   For type S: Insert the sensor in the shut-off pipe until it touches the ball of the ball valve. Now move it approx. 5mm back. Attach the safety chain with the snap hook at the shut-off pipe.

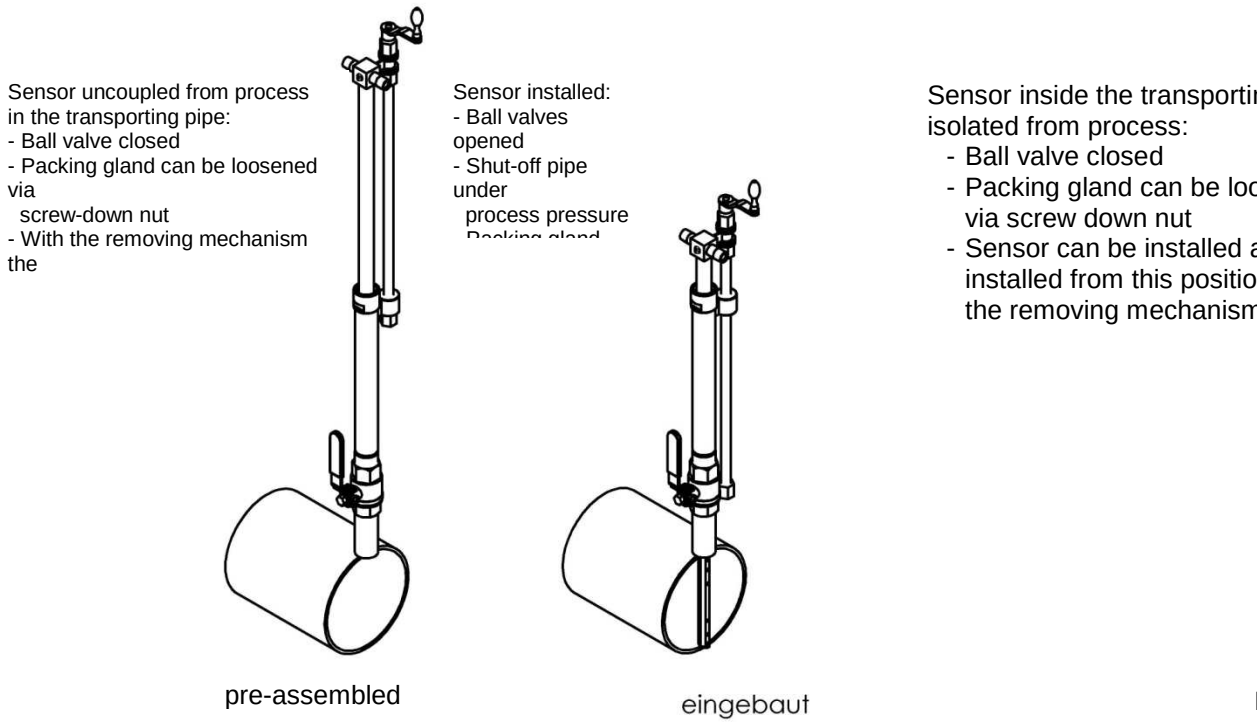


Figure 12: FASTLOK-N Sensor Design

3. Tighten the gland so that it seals the sensor neck pipe but movement of the SDF sensor is possible without too much force.
4. Now open the ball valve carefully. Close the ball valve immediately if the gland leaks and re-tighten the packing gland. A further packing must be inserted under the pressure ring if the gland cannot be tightened further.
5. Move the sensor (for N with the drive spindle) through the fully open ball valve until the sensor point touches the opposite pipe wall if the gland is leak-proof.
6. For installation with end support the sensor is inserted until the distance between pipe outer wall and upper edge sensor head and/or flange plate corresponds with the value marked on the rear of the type label. The sensor point reaches now approx. 30mm into the end support.
7. Check the gland again for leaks and tighten, if necessary.

Important for installation:
First tighten the gland, then carefully open the ball valve!

4.7.1. FASTLOK Sensor Disassembly

The FASTLOK sensors can be removed under process conditions.

1. - FASTLOK-L: Fix the SDF sensor and loosen the mechanical joint to remove the sensor. This must be done with the necessary care! Remove the SDF sensor from the mechanical joint.
   - FASTLOK-S: Ensure that the safety chain is connected to the sensor head. Loosen the gland to remove the sensor. Only remove as far as necessary and very careful (medium may be discharged)! Carefully pull the sensor manually outward, until the ball valve can be closed. The safety chain should now be nearly taut.
   - FASTLOK-N: Remove the sensor with the crank as far from the pipe until the sensor pipe is within the transporting pipe. Loosen the gland somewhat, if necessary. Only loosen carefully and as far as necessary (medium may be discharged)!

2. Close the ball valve **completely** and secure against accidental opening, if necessary!

3. - FASTLOK-S: Loosen the gland completely (Caution, medium may be discharged!) and unhook the safety chain. Remove the sensor manually from the transporting pipe, without wedging the sensor.

   - FASTLOK N: Remove the lock nut at the lower end of the spindle (fixed with grub nut). Loosen the gland completely and crank out the sensor until the spindle is no longer engaged. Remove the sensor manually from the transporting pipe, without wedging the sensor.

Important for disassembly:
First close the ball valve completely, then loosen the gland (for FASTLOK-S/N) and remove the sensor!

5. Connect Pressure Differential Transmitter to Sensor

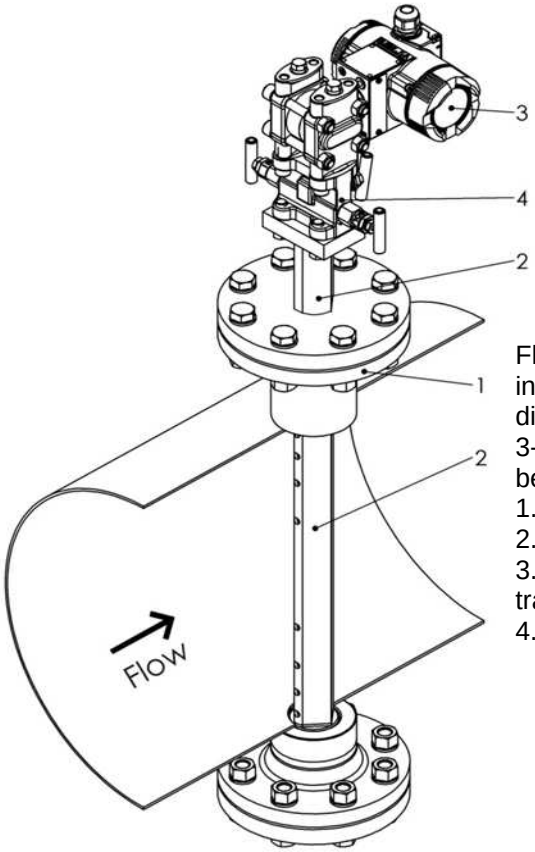
5.1 Sensor with Mounting Plate for Direct Transmitter Connection to the Sensor

The easiest and most cost-effective form of connecting sensor und transmitter is offered by sensors with mounting plate for the direct installation of the transmitter. For this a “sandwich” is made of sensor, 3- or 5-way valve block and transmitter, which are held by 8 screws (4 per side). Condition is that the permissible temperatures at the transducer membrane are not exceeded. The ⊕ side of the transmitter must be connected with the upstream side of the sensor, i.e. with the side in front of the direction of the arrow. Both sealing faces – between sensor and valve block and between valve block and transmitter – must be equipped with sealing rings in the provided grooves. These sealing rings are supplied.

The necessary seals are loosely included with the delivery.

The complete parts list for the start-up of the sensor must include:

- Sensor including the installation components for pipe installation
- 1 3-way valve block for direct installation at transmitter and sensor including all seals and screws
- 1 pressure differential transmitter (will be mounted directly to the sensor, additional support is not necessary)



Flow sensor with direct installed electric pressure difference transmitter and 3-way valve block flanged in-between
1. Installation flange
2. SDF sensor
3. Pressure difference transmitter
4. 3-way valve block

Figure 13: Arrangement of directly installed differential pressure transmitter on 3- or 5-way valve block (Caution: Follow above instructions for installation position!)

The sensor must be installed according to page 7 (Table 3). Zero point balance must be executed before start-up. Both chambers must be under the same pressure. Close an upstream valve and open the middle valve for the pressure to be present at both chambers. See further procedure in the manual of the pressure differential transmitter manufacturer.

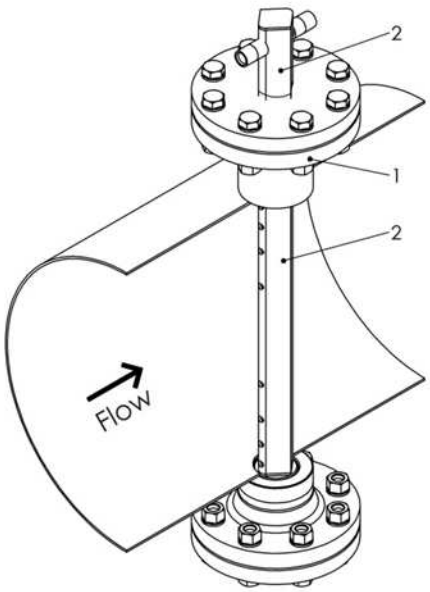
5.2. Sensor with Connection Nipples to Connect the Transmitter via Differential Pressure Pipes

The connection between sensor and remote installed transmitter is made via differential pressure pipes. For this usually pipes are used, which are screwed to the sensor or valve block and transmitter. Generally screw joints with cutting ring or tensioning ring matching the selected pipe connections are used (e.g. ∅12mm or ∅14mm). The screw joints can be ordered from S.K.I. GmbH. For higher pressure generally welding is recommended. For this we offer primary shut-offs with welding joints.

The complete parts list for the start-up of the sensor must include:

- Sensor including the installation components for pipe installation
- 2 ball valves/shut-off valves for initial shut-off of the differential pressure pipes of the flow sensor (can be omitted for “depressurised” pipes)
- 2 fittings each to align the primary shut-off connections of the 3- or 5-way valve blocks with the differential pressure pipe
- 1 3- or 5-way valve block for direct installation on the transducer with matching process connection including all seals and screws and necessary oval adapters
- 1 of differential pressure transmitter with pipe or wall bracket
- Sufficient piping in

Please contact our responsible sale engineer or representative in case you wish start-up of the sensors by S.K.I. GmbH.



Standard flow sensor for horizontal and vertical pipe run:
(e.g. process connection via 12mm pipe and tensioning ring screw joint; Ball valves with tensioning ring screw joint optional)
1. Installation flange
2. SDF sensor

Figure 14: Arrangement for transmitter connection via differential pressure pipes (Caution: follow above instructions for installation position!)

The sensor must be installed according to page 7 (Table 3). **Pipework and pressure differential transmitter connection must be strictly monotonous inclined for gases and strictly monotonous declined for liquids and steam.** Zero balance must be executed before start-up. Both chambers must be under the same pressure. Close an upstream valve and open the middle valve for the pressure to be present at both chambers. See further procedure in the manual of the pressure differential transmitter manufacturer.

6. Specific Characteristics Steam Sensors

6.1. Description of the Measurement Set-Up and Specific Notes

SDF flow sensors for steam are generally supplied with condensate pots (2) and mostly with pre-assembled shut-off valves (5a, 5b). In standard sensors for steam the condensate pots are integrated in the compact head, what simplifies the alignment of the SDF sensor.
The sensors must always be installed horizontally.

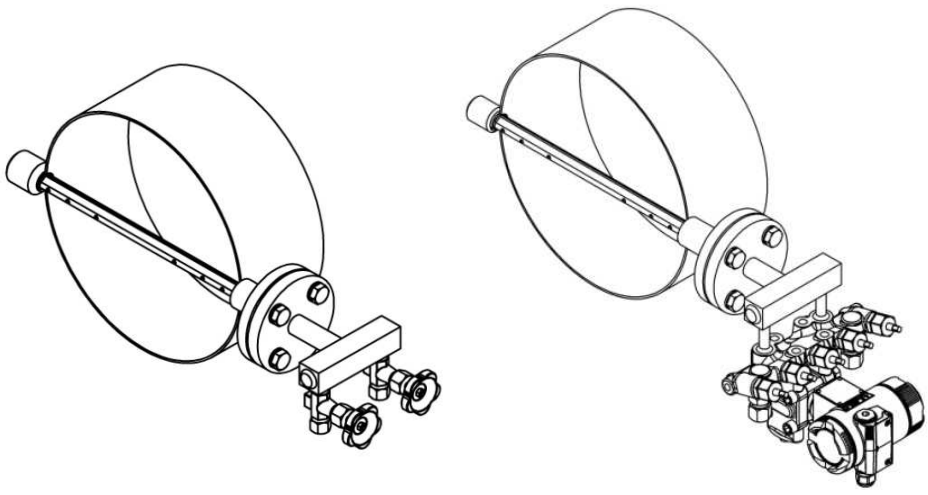
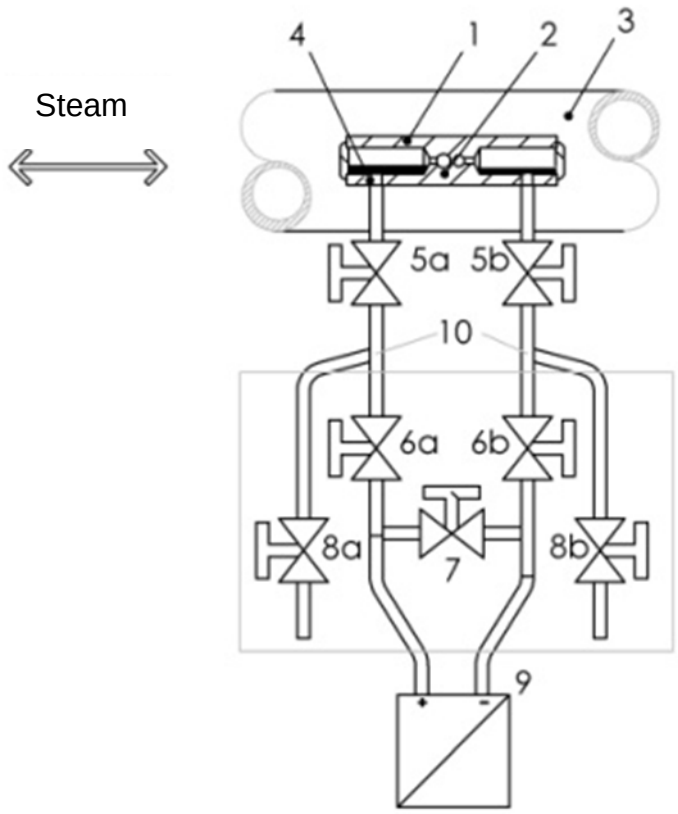


Figure 15: Steam Sensor Illustration (SDF-DF-22)

Separate transducer installation:
The connection between sensor and transmitter is made via compression fitting. Ensure that the compression fittings have sufficient decline over the entire distance towards the pressure differential transmitter. The steam condensates in the pipes and the condensate serves as a guard to avoid direct contact of steam an electronic equipment. Please note that these condensate water columns generate additional pressure at the measuring cell. They can distort the pressure differential measurement if the individual height of condensate columns are not exactly the same.
To ensure equal condensate height the SDF flow sensors are fitted with condensate containers, which are filled with condensate to a clearly defined height during normal operation.

Transmitter direct installation:
Steam sensors for direct installation of the pressure differential transmitter are always supplied with compact head and welded 5-way valve block. Horizontal alignment of the compact head can easily be checked with a spirit level during installation. Due to low condensate receivers the condensate containers integrated in the compact head must be filled with water before measuring start-up via the blow-off valves integrated in the 5-way valve block.



1 Sensor
2 Compact head
3 Steam pipe
4 Measuring pipe connection
5 Initial shut-off
6 Pressure differential valves
7 Counterbalance valves
8 Blow-off valves
9 Transmitter
10 Pressure differential pipe

Figure 16: Measurement Set-Up team Sensors
See the typical pipework and shut-off valve array between sensor and pressure differential transmitter in the measurement set-up. In real life valve combinations 6, 7, 8 are combined in multi-valve blocks. For cost efficiency often the blow-off valves are omitted. In this case valve combination 6a, 6b, 7 is achieved with a 3-way valve block. If in addition blow-off valves 8a, 8b are desired, then a 5-way valve block is deployed.
To protect the transmitter from thermal overload ensure that hot steam does not get straight into the measuring cell. This is achieved with so-called condensate guards (water columns from condensated steam). The transmitter is generally installed in sufficient distance below the sensor.

6.2. Steam Measurement Start-Up

Ensure before measurement start-up that all connections are leak-proof and the impulse pipes and condensate containers are filled.
Fill via the blow-off valves if a 5-way valve block is used. The valves upstream of the transmitter must initially be closed. Filling is only permitted if the water pressure is higher than the steam pressure; otherwise steam can escape. For this reason generally only fill if the steam piping is depressurized. Filling is only possible if primary shut-offs, if present, are open.
For steam sensors with separately installed pressure differential transducer alternatively the accruing condensate can be used for filling. However, this method is time-consuming. After installation close all valves initially. Condensate collects in the condensate container. Open the primary shut-offs after a while for the condensate to run into the impulse pipes. After some more waiting open the pressure differential valves of the valve block and the cooled condensate reaches the measurement cell. After the condensate containers have filled again zero balancing can be carried out (first close the pressure differential valves and then open the counterbalance valve) and the measurement can be started.

7. Specific Characteristics FASTLOK Sensor

Advantages and Areas Of Application For FASTLOK Sensors

FASTLOK sensors are used if installation and disassembly are to be ensured during operation. For adjusting the process data different FASTLOK sensor versions are available: FASTLOK-L sensor without safeguard against moving of the sensor; FASTLOK-S sensor with a safety chain; FASTLOK-N sensor with a spindle. Generally a version up to pressure stage PN63 is possible.

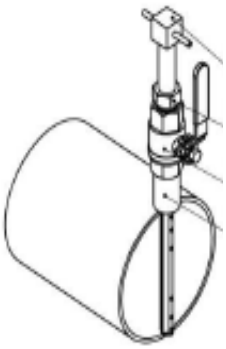
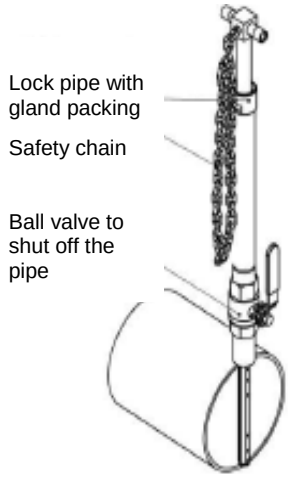
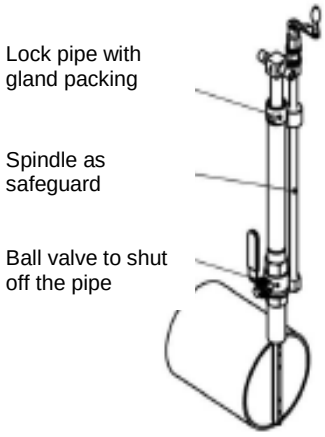
FASTLOK-L sensors without pull-out mechanism (PN2)	FASTLOK-S sensors with pull-out safeguard (max. PN6)	FASTLOK-N sensors with simple pull-out mechanism (max. PN16)
The most simple of all FASTLOK sensors is suitable for a further application as standard sensor everywhere, where in the range of the atmospheric pressure or slight over or under pressure in non-toxic gaseous media is to be measured. Here the pressure differential sensor can be removed without specific pull-out mechanism from the process pipe. The primary shut-off is made with the ball valve directly at the pipe, as shown in the illustration. Especially convenient is the combination of FASTLOK L sensors with a pressure differential transducer or flexible tubes as differential pressure pipe, which are directly mounted on a flange plate; here the complete array can be moved without any further disassembly. FASTLOK-L type is available for profiles “10” and “22”.	FASTLOK-S type is used if sealing of the pipe and securing of the sensor during installation and disassembly is necessary (e.g. in water or steam pipes), but can be held without risk with normal force in the pipe. Contrary to the L type the pipe is shut off before removing the sensor completely from the installation equipment. In this way only the media inside the equipment escapes (lock).	SDF sensor types FASTLOK-N are suitable for the safe installation and disassembly at higher pressure (max. PN16, 150 lbs) by only one person. The installation and disassembly mechanism allows controlled installation and disassembly with self-protection up to sealing the pipe and complete disassembly at any time. Via the valves on the transducer or primary shut-offs the residual pressure inside the installation equipment can be completely discharged before the complete disassembly of the sensor. FASTLOK-N types have a standard hand crank to actuate the installation mechanism.
		
FASTLOK L	**FASTLOK S**	**FASTLOK N**

Table 9: Design Overview FASTLOK Sensors

Start-up of FASTLOK sensors is similar to start-up described above for “Standard” sensors.

8. Troubleshooting

Pos.	*Trouble*	*Possible Cause*
	Sensor	
1	No or too low pressure differential	- Sensor not installed in flow direction
		- Pressure differential connections between sensor and transducer confused (see page 7) (upstream side of sensor not connected to “+” transducer chamber and downstream side of sensor not connected to “-” transducer chamber)
		- Primary shut-off “+” and/or “-” side not open
		- Counterbalance valve not closed
		- Leaks in pressure differential pipework
		- Sensor(s)/ drill holes blocked
		- Upstream and downstream distances too short (see page 6)
		- Air locks in sensor head/ differential pressure pipe or transducer (see also pos. 3 / *for steam and liquid measurements*)
		- Condensate in sensor head/ differential pressure pipe or transducer (see also pos. 4 / *for gas measurement*)
		- Sensor not completely with all drill holes inside the free pipe diameter (see page 12)
		- Condensate containers or condensate receivers not aligned on equal height (different condensate column heights, see page 20, *only for steam measurement*)
2	Measurement range exceeded	- Upstream and downstream distances too short (see page 6)
		- Primary shut-off in differential pressure pipe of “-” side not open
		- Sensor(s)/ drill holes blocked
		- Sensor not completely with all drill holes inside the free pipe diameter (see page 12)
		- Condensate containers or condensate receivers not aligned on equal height (different condensate column heights, see page 20, *only for steam measurement*)
3	Trapped air in sensor/ differential pressure pipe and/or transmitter *(for liquid measurement)*	- Faulty installation of SDF-sensor or differential pressure transmitter (see page 7)
		- Incorrect bleeding (see user manual pressure differential transmitter)
		- Differential pressure pipes installed without decline (see page 20, *for steam and liquid measurements*)
		- Transducer not installed below sensor (see page 20, *for steam and liquid measurements*)
4	Condensate formation in sensor/ differential pressure pipe and/or transmitter *(for gas measurements)*	- Faulty installation of SDF sensor (see page 7)
	Pressure differential-Transmitter	
5	No or wrong output signal	- Faulty installation of differential pressure transmitter (see user manual pressure differential transmitter)
		- Wrong wiring transmitter (see user manual pressure differential transmitter)
		- Transmitter incorrectly parameterised (see pressure differential calculation flow sensor)
		- No zero balance of transmitter (see page 20)
		- Measurement cells admitted with hot condensate/ steam (*only for steam measurement*)

We are aware that this list cannot be complete. Please contact us directly if problems occur, which are not included in this list.

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